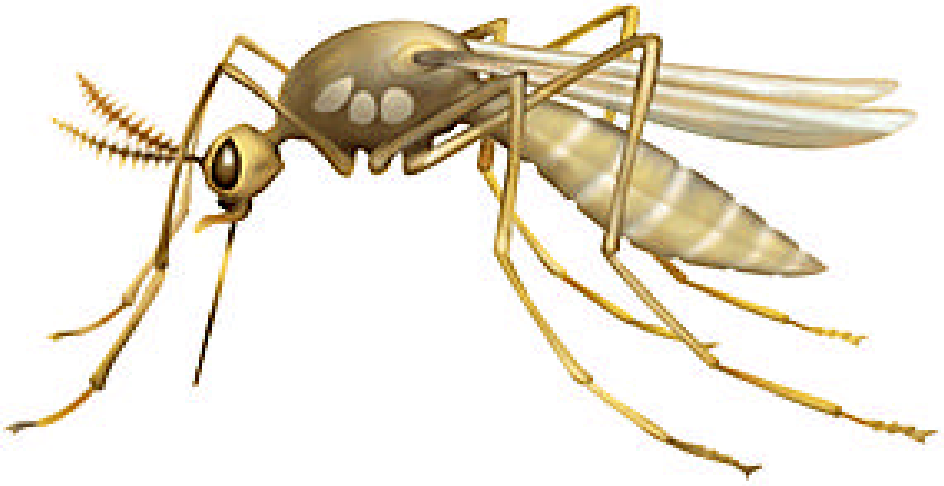
NEATO MOSQUITO



An Elementary Curriculum Guide

produced by:

Division of Vector-Borne Infectious Diseases
National Centers for Infectious Disease
Centers for Disease Control and Prevention

for

Nicholas County, West Virginia Elementary Schools

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produced by:

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Table of Contents

Introduction 3

Lesson 1 - Life History of the Mosquito 5

Lesson 2 - Mosquitoes Suck**:** Feeding on Flower Nectar and Blood 12

Lesson 3 - the Circle of Life: Mosquito Ecology 15

Lesson 4 - Mosquitoes and Disease. 18

Lesson 5 - Preventing LaCrosse Encephalitis. 28

Vocabulary List 31

Mosquito Math Problems 34

Top 10 Mosquito Fun Facts 35

Balancing Mosquito 36

Crossword Puzzles 38

Mosquito Line Drawings 48

Description of all slides. 53

Overheads 55

Slides 80

Videotape . . . . . .

NEATO MOSQUITO

Introduction

I. Background

LaCrosse encephalitis is a mosquito-transmitted disease, primarily affecting children under 15 years of age. Historically, most cases of LaCrosse encephalitis (inflammation of the brain) occur in the Upper Midwest and Great Lakes states (Minnesota, Wisconsin, Iowa, Illinois, Indiana, and Ohio). In the past 7 years, large increases in LAC encephalitis cases have been reported from the mid-Atlantic and southeastern states. West Virginia currently leads the nation in the number of LaCrosse (LAC) encephalitis cases reported each year. During 1996, West Virginia reported 66 (59%) of the 111 cases reported nationwide. Most of the cases in the state have occurred in Nicholas County and surrounding counties. During the 3 years 1994 through 1996, the incidence of LAC encephalitis in Nicholas County ranged from 1.2 to 3.0 cases per 1000 children under 16 years of age living in the county.

In response to the increase in LAC encephalitis cases from West Virginia, the West Virginia Dept. of Health and Human Resources and the Centers for Disease Control and Prevention's Division of Vector-Borne Infectious Diseases have developed a number of collaborative projects. These are aimed at increasing awareness and reporting of LAC cases, determining the ecological parameters influencing LAC transmission cycles, developing and evaluating mosquito management options, and developing and evaluating public education programs.

This curriculum resource package is part of an educational program in Nicholas County. It is designed to increase the public's knowledge and awareness about LAC encephalitis and to show how they can reduce their risk of getting the disease.

II. Purpose

Educating children and their parents will be a critical component in a successful program to reduce the incidence of LAC encephalitis in West Virginia. Several environmental and behavioral risk factors associated with LAC encephalitis have been identified. Reducing LAC risk primarily involves taking actions to reduce contact between children and mosquitoes. The most important risk-reduction actions are removing mosquito habitats from around the home and using personal insect repellents when working/playing outdoors during the summer months.

As with other public health education programs, it is essential that the public be aware and understand why it is being asked to take certain actions. One of the most effective ways to communicate a public health message is through children, by presenting the ideas logically and in an interesting fashion in school. Not only is the information incorporated into the experience of the student, but also the message is often carried home to the parents. This is our goal in developing the NEATO MOSQUITO educational program.

This package presents information about mosquito biology, mosquitoes in the ecosystem, and mosquitoes as vectors of disease. Special emphasis is placed on the details of LaCrosse encephalitis, the mosquito that transmits LAC virus, and ways to reduce the risk of getting bitten by those mosquitoes. The material is presented in a manner that will allow it to be adapted to meet the needs of other educational settings beyond the 4th - 6th grades.

III. Contents

The material is presented in five separate lessons. They are intended to be presented in sequence, but components may be extracted from the program as the teacher deems appropriate.

- Lesson 1 - Life History of the Mosquito

- Lesson 2 - Mosquitoes Suck: Feeding on Flower Nectar and Blood
- Lesson 3 - The Circle of Life: Mosquito Ecology
- Lesson 4 - Mosquitoes and Disease
- Lesson 5 - Preventing LaCrosse Encephalitis

IV. Support materials

Support materials include overhead projector transparencies (35mm slides of the same images are included), videotape sequences of live mosquitoes, line drawings suitable for coloring, a craft item, crossword puzzles, and an individual-class project.

V. References

Spray, Francis J. *Mosquitoes in the Classroom: Teacher and Resource Guide & Classroom Curriculum*. Kendal/Hunt Publishing Co., Dubuque, IA, 1995. ISBN 0-7872-0703-6.

Patent, Dorothy H., *Mosquitoes*. Holiday House, New York, 1986. ISBN 0-8234-0627-X.

Leahy, Anna. *The Insect Workbook*. Entomological Society of America. Lanham, MD, 1994. ISBN 0-938522-51-5.

Photographic images in slides, overheads, and videotape produced by: Jack Leonard, Ralph E. Harbach, Leonard E. Munstermann, Edward Ross, Chester G. Moore, Roger S. Nasci.

LESSON 1

LIFE HISTORY OF THE MOSQUITO

Preparation Time: min. Teaching Time: min.

Desired Outcome

- The student will be able to name and describe the four stages of the mosquito life cycle, describe the physical differences between adult male and female mosquitoes, and describe types of larval habitats used by different mosquito species.

Lesson Objectives

- Describe the four stages of the mosquito life cycle (egg, larva, pupa, adult).
- Describe the function of each stage.
- Identify the main body parts of the adult mosquito.
- Identify male and female mosquitoes.
- Describe larval habitat types.
- Describe the treehole mosquito habitat and life cycle.

Materials Supplied

- Slides/overheads of mosquito life stages.
- Videotape (VHS) of live mosquito life stages.
- Line drawings of mosquito life stages (suitable for coloring).
- Line drawings of adult male and female mosquitoes (suitable for coloring).
- Slides/overheads of various mosquito larval habitats.
- Slides/overheads of container habitats used by the treehole mosquito.
- Balancing-mosquito model.
- Teacher's notes.

Needed Materials

- Audiovisual equipment (overhead or slide projector, videotape player, television)
- Pencils, colored markers, cardboard, white glue
- Scissors
- Pennies
- Tape

Slides/overheads

Slide 1	Neato Mosquito: Adult female mosquito taking a blood meal. This individual is *Aedes triseriatus*, the treehole mosquito, vector of LaCrosse encephalitis virus.
Slide 2	Mosquito Life Cycle: Color photographs of floodwater mosquito eggs laid on a leaf surface, larvae, pupa, and adult.
Slide 3	Eggs: Color photographs of a female mosquito laying an egg raft, eggs of a floodwater mosquito laid on a fallen leaf surface, and an electron micrograph showing the surface of a mosquito egg shell.
Slide 4	Larva: Color photograph and line drawing of a mosquito larva showing major body parts. Electron micrograph of a mosquito larva head showing the mouth brushes.

Slide 5	Pupa: Color photograph and line drawing of a mosquito pupa showing major body parts.
Slide 6	Adult Emerging from Pupa: Line drawing of an adult emerging from the pupal stage.
Slide 7	Adult Mosquito: Color photograph and line drawing showing the major body parts. Electron micrograph of an adult mosquito head showing the eye, antenna, and proboscis.
Slide 8	Adult Mosquito: Color photograph and line drawings showing the difference in antenna structure of male and female mosquitoes.
Slide 9	Mosquito Habitats: Color photographs of permanent water habitats (a swamp) and floodwater habitats (a flooded field).
Slide 10	Container Habitats: Color photographs of a treehole (natural container) and various man-made containers.
Slide 24	Balancing Mosquito: Diagram of the template for constructing the balancing mosquito.

Videotape:
The videotape contains images of the life stages of the treehole mosquito, *Aedes triseriatus*. The videotape segments relevant to lesson 1 include: mosquito larvae hatching from eggs, larvae swimming, larvae feeding (mouth brushes can be seen moving rapidly, filtering particles from the water), pupae swimming, an adult emerging from the pupal stage, adult male and female characteristics, and a female laying eggs above the water line. The tape also includes images of a female treehole mosquito blood feeding.

Teacher's Notes, Lesson 1:

Mosquitoes belong to a large group of insects called the **Diptera** (Slide 1). This group also includes the flies, midges, and gnats. All of these insects have two wings, which is where they get their name (Diptera: di = two, pteron = wing). The word "mosquito" derives from the Spanish term "mosca", meaning fly.

There are about 3000 different species of mosquitoes throughout the world, and about 165 of them can be found in the United States. A **species** is unique group of organisms that is different from every other group, either in their appearance, behavior, or ecology.

Like all other insects, mosquitoes go through distinct stages in their life cycle, progressing from immature to adult (Slide 2). Just as a caterpillar turns into a moth, the mosquito changes appearance during its life cycle. In insects, this process of development from immature to adult is called **metamorphosis** (meta=change, morph=shape). In order to develop and grow, insects **molt**, or shed their old skin.

The four stages in the mosquito life cycle are: **egg**, **larva**, **pupa**, and **adult**.

The **egg** contains the developing **embryo** of the mosquito (Slide 3). Just like the egg of a chicken, the mosquito egg has a protective outer shell. Inside the shell is food (protein, carbohydrates, and water) to nourish the embryo as it develops. The eggs are laid by the female mosquito in or near water, because the next life cycle stage lives in water. Some mosquito species lay up to 300 eggs clustered into a **raft** that floats on top of the water; some species lay single eggs that float on the surface. If the weather conditions are right, these eggs will hatch in 1 to 5 days. Some mosquito species don't lay their eggs directly in the water but select areas that will eventually be underwater. Female mosquitoes of these species sense areas that will be flooded either by rainfall or by snow melt. Eggs of these species can withstand very cold temperatures and can lie dormant over the winter. When warm, wet weather arrives in the spring, these eggs will hatch.

When a mosquito egg hatches, a tiny **larva** emerges (Slide 4). Sometimes mosquito larvae are called **wrigglers** because they are worm-like and swim by wiggling through the water. The mosquito larva is **aquatic.** It lives in water, where it feeds on bacteria, algae, and a variety of organic debris. It feeds by filtering the small particles out of the water with thousands of tiny brushes on its mouthparts. These brushes are constantly in motion, sweeping particles from the water and pushing them into the larva's mouth. The newly-hatched larva is barely visible to the eye. As the small, first-stage larva eats, it grows and eventually molts into a larger, second-stage larva. This process continues until it reaches the fourth and last larval stage. By this time, the larva is easily visible and swims actively. Though the larva lives in water, it must breathe air. Most mosquito species have a **siphon**, or breathing tube, at the base of their tails. The larva swims to the surface of the water and breathes through the siphon like a swimmer would use a snorkel. Some mosquitoes never come to the surface of the water but have specialized siphons that get their oxygen by puncturing the roots of plants in the water. The purpose of the larval stage is growth. Mosquitoes may be larvae for one to four weeks, depending on the species and the temperature.

When the last larval stage molts, a very different looking creature comes out (Slide 5). This stage is called the **pupa.** The pupa looks like a fat "comma" with ears. The ears are a pair of breathing tubes called **trumpets** that the pupa uses to breathe, just like the larva uses the siphon. The pupa has no mouth and does not eat; however, it can swim to avoid predators in the water. When it swims, it tumbles erratically through the water; it floats back to the surface when it stops swimming. Mosquito pupae (plural) are frequently referred to as **tumblers**. The purpose of the pupa is **metamorphosis** from the larval stage to the adult stage. Within the pupa, big changes are happening. The old tissues of the larvae are being broken down and adult tissues are being built up. The digestive system is changing from one that handles small food particles to one that can feed on liquids (the adult diet). The legs, wings, eyes, and other adult characteristics are developing. The pupal stage lasts from one to three days, depending on temperature.

At the completion of the pupal stage, the pupa becomes very still (Slide 6). The skin splits open along the back of the pupa, and the adult mosquito gradually emerges through this opening. The process takes about 5 minutes. The newly emerged adult mosquito floats on the surface of the water for a few minutes, allowing its new body to harden and the wings to expand, before it flies away.

The **adult** mosquito is constructed like a typical insect (Slide 7). It has three body parts: the **head**, the **thorax**, and the **abdomen.** The head has a large pair of eyes and a pair of antennae. Like us, the mosquito uses its **eyes** to see the world around it. The **antennae** are used to hear and smell. The mosquito's mouth, called the **proboscis** (from Greek: pro=in front, boskein=to feed), is long and thin for sucking up flower nectar and blood. On the thorax is a pair of delicate-looking wings and six long, slender legs.

Comparing male and female mosquitoes side by side is the best way to distinguish the sexes (Slide 8). The easiest way to tell a male from a female is to look at the antennae. The male's antennae are bushy, covered with long fine hairs. The female's antennae are covered with much shorter hairs. Male mosquitoes use their antennae to listen for females. The males can sense the wing vibrations of the females of their own species. Mosquito wings beat very quickly, from 300 to 600 times per second. Humans can hear the characteristic whining buzz that mosquito wings make when they fly. The purpose of the adult mosquito stage is **reproduction**.

Mosquitoes can be found from the equator to the Arctic. While all mosquitoes require water for their larvae to develop, different species use different types of aquatic habitats (Slide 9). Generally, mosquito larval habitats are divided into two categories: **permanent water** and **floodwater**. Permanent water larval habitats include swamps, marshes, ponds, and the edges of calm lakes and streams. Ditches that are constantly full of water are also permanent water habitats. Mosquitoes using permanent water lay their eggs as rafts or as single eggs floating on the surface of the water. Floodwater habitats include low-lying fields and woods that flood either from snow melt in the spring or rainfall at any time of the year. Mosquitoes using floodwater habitats lay their eggs on the soil or on the leaves in the areas that will flood. The female mosquito knows where to lay her eggs because she can detect areas that will flood by the appearance and smell of the habitat. Floodwater mosquito eggs may be very abundant in the soil, and a heavy rainfall may result in millions of eggs being flooded and hatching at the same time. Huge numbers of hungry adult mosquitoes can emerge from relatively small floodwater habitats.

Some mosquito species that useflood water habitats are very specialized. Instead of using flooded fields or woodlands, they use small **containers** that will fill with water during a rainfall (Slide 10). The mosquitoes are laid on the sides of the container, above the level of the water. When rain fills the container, the eggs are covered with water and hatch. Almost any container that holds water can serve as a habitat for mosquitoes. Some species live in **natural containers**, such as the junction between branches of trees, where water collects; some live in the holes formed in trees when branches break off. Some species in the tropics use broken bamboo stems and others use coconut shells. **Man-made containers** are also important mosquito habitats. Mosquitoes can use buckets, cans, flower pots, or old tires as larval habitats. Many of these man-made containers can be found around our houses, and are important sources of mosquitoes near our homes.

One of the mosquitoes that uses container habitats in West Virginia is the mosquito species, ***Aedes triseriatus*** (Slide 1). This is the scientific name for a mosquito that is more commonly known as the **treehole mosquito.** By scientific convention, every identified species has a unique name that consists of two parts. The first part is the **genus**, and the second part is the **species**. The name is usually from Latin or Greek words and can describe some characteristic of the species. However, it is often more convenient to use the common name of the species.

The treehole mosquito, as the name implies, uses holes in trees as the larval habitat (Slide 10). If you look carefully around the woods, you will eventually find holes either where a branch broke off or where there is a natural cavity in the bark. Some of these will hold water, and in that water you may find larvae of the treehole mosquito. The adult female treehole mosquito is very good at finding treeholes that will hold water, and lays her eggs in them. Treehole mosquitoes

also lay their eggs in man-made containers like buckets, cans, and tires. This means we often grow treehole mosquitoes right near our own homes.

Vocabulary (ordered as appearing in teacher's notes)

Diptera-	Order of insects that has only two wings (one pair). Most others insect orders have four wings (two pairs).
species-	A unique group of animals, different from other groups.
metamorphosis-	The maturing process that involves changes in shape between hatching and becoming an adult.
molt-	To shed the skin in order to grow.
egg-	The first stage in the life cycle.
larva-	The immature, wingless form that hatches from an egg. Purpose is to eat and grow.
pupa-	The non-feeding stage in the life cycle during which the larva changes to the adult form.
adult-	The fully developed mature form.
embryo-	The developmental stage found inside the egg.
raft-	Cluster of eggs laid on the surface of permanent water.
wriggler-	Common name for the mosquito larva.
aquatic-	Living in water.
siphon-	Tube used by the larva to breathe air.
trumpet-	Tube used by the pupa to breathe air.
tumbler-	Common name for the mosquito pupa.
head-	Part of the body that contains the eyes and mouth.
thorax-	Part of the body that contains the legs and wings.
abdomen-	Part of the body that contains the digestive and reproductive organs.
eyes-	Visual organs on the head, composed of numerous separate lenses.
antenna-	Sensory organ on the head for hearing and smell.
proboscis-	Elongated mouth of the mosquito, adapted for feeding on liquid (from Greek: pro=in front, boskein=to feed.
reproduction-	The making of offspring.
permanent water-	Aquatic habitat that is relatively stable. The water level doesn't fluctuate.
floodwater-	Aquatic habitat characterized by fluctuating water levels.

container (natural)-	Specialized floodwater habitat used by some mosquitoes. Treehole is primary example.
container (man-made)-	Specialized floodwater habitat used by some mosquitoes. Buckets, cans, and discarded tires are examples.
Aedes triseriatus-	The genus and species name for the treehole mosquito, the vector of LaCrosse encephalitis virus.
treehole mosquito-	Common name for the mosquito, *Aedes triseriatus*.
Genus species-	Conventional way scientists name a type of animal or plant. The proper scientific name always consists of the two names.

LESSON 2

MOSQUITOES SUCK: FEEDING ON FLOWER NECTAR AND BLOOD

Preparation Time: min. Teaching Time: min.

Desired Outcome

- The student will be able to describe what mosquitoes eat, why female mosquitoes consume blood, and how they find blood meal hosts.

Lesson Objectives

- Describe how mosquito mouthparts are adapted for feeding on liquids.
- Describe the foods used by adult male and female mosquitoes.
- Use blood-meal host preferences to expand on the species concept, emphasizing the treehole mosquito.
- Explain why female mosquitoes must consume blood.
- Describe how female mosquitoes locate hosts.
- Describe the mechanics of blood feeding.
- Explain why mosquito bites itch.

Materials Supplied

- Slides/overheads of mosquito mouthparts.
- Slides/overheads of mosquitoes feeding.
- Videotape (VHS) of mosquito feeding.
- Teacher's notes.
- Vocabulary list.

Needed Materials

- Audiovisual equipment (overhead or slide projector, videotape player, television)

Slides/overheads

Slide 11	Host Location: Line drawing showing mosquitoes using carbon dioxide to detect hosts at a distance and using heat, moisture, and vision to locate the host when they get closer.
Slide 12	Mosquito Blood Feeding: Color photographs and line drawings showing the labium (sheath) sliding back from the stylets (feeding tube) as they are inserted into the skin.

Videotape:
The videotape segment relevant to Lesson 1 contains images of a female treehole mosquito blood feeding.

Teacher's Notes, Lesson 2:
Mosquitoes can only feed on liquids because of the shape of their mouths (Slide 7). The mouth of the mosquito is called a **proboscis** (from Greek: pro=in front, boskein=to feed), and is actually like a long, thin straw. Adult mosquitoes, both male and female, require a constant supply of food to survive. Plants provide the source of food. Plant juices are rich in **carbohydrates** (sugar), and mosquitoes regularly feed on flower nectar, fruit juices, and liquids that ooze from injured plants.

Only female mosquitoes have a proboscis that is adapted for piercing skin, and only the females feed on blood. Female mosquitoes obtain their blood meals from a variety of animals. These include warm-blooded animals like birds, deer, cattle, and dogs. Some mosquito species feed on cold-blooded animals like frogs, turtles, and snakes. There are mosquito species that prefer only one type of **host**. For example, they will feed only on birds. Other mosquito species have no preference and will feed on a wide range of hosts. Actually, very few mosquitoes feed on humans. The treehole mosquito is well adapted to living in the forest. It feeds primarily on chipmunks, squirrels, and deer. The treehole mosquito will also readily feed on humans, if they are available.

The female mosquito needs to feed on blood to complete its life cycle. Blood is a very high **protein** liquid. The female mosquito requires the proteins in blood to produce the shell and yolk of her eggs. For each batch of eggs laid by a female mosquito, she needs a fresh blood meal. There is so much protein in blood that a female mosquito can produce 100 to 300 eggs from a single blood meal.

Mosquitoes find their blood meal hosts by smell and vision (Slide 11). When the mosquito is far away from you, she can smell the **carbon dioxide** that you exhale. All animals exhale carbon dioxide. The female mosquito can smell very low concentrations of carbon dioxide. When she senses it in the air, she follows it to the source by flying in the direction where the carbon dioxide smell is strongest. When she gets closer to you she is attracted by the heat and moisture your body gives off. Finally, when she is very close, she uses vision to find a place to land on you.

Mosquitoes are so light and delicate that you rarely feel them landing on you (Slide 12). The female mosquito typically weighs about 2.0 milligrams (0.0007 ounces) before a blood meal. When a hungry female mosquito lands, she starts probing your skin with the tip of her proboscis. When she finds a suitable spot, the proboscis is pushed against the skin. The sheath-like **labium** folds back, and the mosquito begins to insert the very sharp and slender **stylets** into the skin. Once in the skin, the mosquito probes the stylets around through the small blood vessels. When blood is located, a pump in the head sucks the blood up through a **food canal** in the stylets, and into the stomach. It takes about 1 - 3 minutes for the mosquito to finish feeding. While this is happening, another pump in the head of the mosquito is pumping **saliva** into the skin through the **salivary canal**, another channel in the stylets. Chemicals in the saliva act as anesthetics so you can't feel the mosquito feeding. They also keep the blood from clotting in the food canal. It is the saliva that makes mosquito bites itch. Your body knows that the saliva shouldn't be there and reacts to its presence. The cells of your immune system rush to the site of the bite to get rid of the saliva. Chemicals released by these cells cause the swelling and itching. So, the itch of a mosquito bite is actually an immune reaction in your body, in response to the saliva.

Vocabulary (ordered as appearing in teacher's notes)

proboscis-	Elongated mouth of the mosquito, adapted for feeding on liquid (from Greek: pro=in front, boskein=to feed.
carbohydrate-	A group of chemical compounds that includes sugars.
host-	The animal from which the mosquito takes a blood meal.
carbon dioxide-	Chemical compound that all animals exhale
labium-	Sheath that covers the stylets, part of the proboscis.

stylets-	Thin, sharp structures that penetrate the skin, part of the proboscis.
food canal-	Tube within the stylets that conducts blood from the skin to the mosquito's stomach.
saliva-	Secretion injected into the skin when the mosquito bites. Contains anesthetics and anticoagulants to make blood feeding easier.
salivary canal-	Tube within the stylets that conducts the saliva from the salivary gland into the skin.